An empirical study of end-user information system satisfaction using Doll and Torkzadeh instrument: The case of an Iranian power holding company

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Abstract - **Assessing the effectiveness or success of information systems within organizations is one of the most critical issues of information system management field. Considering the subjectivity of information system success, many surrogate measures have been developed by many researchers. End-user information system satisfaction (EUISS) is probably the most widely used measure of information system success. It can be defined as the overall evaluation of an end-user regarding his/her experience related with the information system.**

In this paper we use a 12-item instrument developed by Doll and Torkzadeh to study EUISS. This instrument has been accepted in literature vastly and measures the satisfaction of information systems end-users in five different dimensions: content, accuracy, format, ease of use and timeliness. However, to date, this instrument has not been tested in an Iranian setting.

The instrument has been applied in an Iranian power holding company. A sample of end-users has been taken and asked to answer to a pre-designed questionnaire. Then, validity of the questionnaire is evaluated through convergent validity and reliability tests. Discriminant analysis has also been applied. After the validity of the questionnaire is confirmed, Kruskal-Wallis and two-way ANOVA tests are applied to analyze the results.

Keywords - **Doll and Torkzadeh instrument, End-user information system satisfaction, Measure**

I. INTRODUCTION

Investment of organizations on information technology (IT) and information systems (IS) has been growing more than ever. As investment on information systems continues to increase, the consequences of failure become more critical [5], because they are expensive and demand high cost for implementation. As a result, the decision to install an information system necessitates a choice of mechanisms to determine whether an information system is needed, and once implemented, whether it is functioning properly [3].

This, in turn, has created an increased need to reliable ways to measure the success of an organization's IS. The effectiveness or successfulness of information systems has been noticed increasingly and its assessment within organizations has long been identified as one of the most critical issues of IS management field [8].

As information systems can be viewed in different ways [6], successful information systems can be identified by certain characteristics or metrics. A large number of IS success measures exist. A variety of factors also affect information systems during their development and implementation. As a result, the evaluation of an IS in terms of its "success" is an inherently complex phenomenon.

Considering the fact that IS success or effectiveness is a subjective and multi-dimensional construct [9], many surrogates measures have been developed by many researchers. These measures describe IS success in various terms such as system performance, quality, usage, users satisfaction, etc.

Among different forms of IS effectiveness or success assessment, end-user IS satisfaction (EUISS) is one of the most widely used measures and a large amount of research has been done on its measurement [2, 3, 6, 7, 10, 11].

Doll and Torkzadeh developed an instrument to measure IS user satisfaction. It comprises a set of best-known measures and probably is the most well-known and frequently tested instrument in the literature and many researchers have demonstrated the validity of this instrument (i.e. content validity, construct validity, and reliability) as well as internal validity and statistical conclusion validity [2, 3, 7, 12-16]. The results of these studies also confirm the external validity of this instrument [17]. However, to date, this instrument has not been tested in an Iranian setting.

The paper is organized as follows: First, we review the concept of end-user IS satisfaction and related issues. It is followed by an overview of Doll and Torkzadeh EUISS measurement instrument. Then, we describe research methodology. A sample of users in an Iranian power holding company is taken and asked to answer to a pre-designed questionnaire based on Doll and Torkzadeh instrument. Validity of the instrument is evaluated through convergent validity and reliability tests. Discriminant analysis is also applied. Finally, when the validity of the instrument is confirmed, Kruskal-Wallis and two-way ANOVA tests are used to analyze the results.

II. END-USER IS SATISFACTION

End-user information system satisfaction is probably the most widely used measure of information system success or effectiveness. Not only does satisfaction have a high degree of face validity due to reliable instruments

having been developed by past researchers, but also most other measures are either conceptually weak or empirically difficult to validate [4, 10].

The concept of user information satisfaction originated with Cyert and March. They suggested that an IS which meets the needs of the user reinforces satisfaction with the system [3, 17].

Satisfaction in a given situation is the sum of one's feelings and attitudes toward a variety of factors affecting the situation and user information satisfaction can be defined as the extent to which users believe the information system available to them meets their information requirements [3, 11]. The measurement of users satisfaction with an IS remains of prime concern to researchers [1] and many of them bring it into consideration from different aspects.

Here, we consider end-user satisfaction with an information system as the overall evaluation (both affective and cognitive) an end-user has with respect to his or her experience related with the information system. The term experience in this definition can be made more specific to focus upon different aspects related to the information system and IS end-users refer to those personnel who use or interact with the system directly, as opposed to technical personnel who design the system [2, 6]. In this way, EUISS is consistent with past researches.

III. DOLL AND TORKZADEH INSTRUMENT FOR END-USER IS SATISFACTION MEASUREMENT

The construct of EUISS has been operationalized in different ways and many researchers such as Gallagher [21], Ricketts and Jenkins [22], Lessig and Larcker [23], Pearson [11] and Ives et al. [3] have performed several attempts to develop reliable and valid user satisfaction measurement instruments.

Doll and Torkzadeh [7] considered many studies and tried to develop a comprehensive instrument. First, they derived 31 items from past researches and developed a 40-item instrument using a five point Likert-type scale to measure the end-user satisfaction. After doing a pilot study, they could reduce the first 40 items to 18 ones.

To further explore this 18-item instrument, they conducted another survey. They gathered data and performed an exploratory factor analysis to identify the underlying factors or components of end-user satisfaction which form the end-user satisfaction construct. To achieve more precise and interpretable factors, the analysis was conducted specifying two, three, four, five and six factors. The researchers felt that specifying five factors resulting in the most interpretable structure. These factors were interpreted as content, accuracy, format, ease of use, and timeliness and explained 78.0 percent of the variance [7].

They modified the instrument and reduced it into a 12-item scale and examined its convergent and discriminant validity and assessed its reliability. This 12-item instrument had a reliability of .92 and a criterion-

related validity of .76. The criterion was the separate measure of overall end-user satisfaction. The reliability (alpha) of each factor was: content = .89, accuracy = .91, format = .78, ease of use = .85 and timeliness = .82. The correlation of each factor with the criterion was: content = .69, accuracy = .55, format = .60, ease of use = .58 and timeliness = .60 [7]. The final instrument is shown in table I.

TABLE I
DOLL AND TORKZADEH INSTRUMENT FOR END-USER IS MEASUREMENT

Factors	Questions
Content	1. Does the system provide the precise information you need? 2. Does the information content meet your needs? 3. Does the system provide reports that seem to be just about exactly what you need? 4. Does the system provide sufficient information?
Accuracy	5. Is the system accurate? 6. Are you satisfied with the accuracy of the system?
Format	7. Do you think the output is presented in a useful format? 8. Is the information clear?
Ease of use	9. Is the system user friendly? 10. Is the system easy to use?
Timeliness	11. Do you get the information you need in time? 12. Does the system provide up-to-date information?

This instrument is easy to use, and appropriate for both academic research and practice. Many researches have demonstrated the content validity, construct validity, as well as internal validity and statistical conclusion validity and reliability of this instrument [2, 3, 7, 12-16].

IV. RESEARCH METHOD

In this paper, we assess end-user IS satisfaction using Doll and Torkzadeh instrument in an Iranian power holding company. The company has about 1500 employees and is divided into six separate departments.

Our study is restricted to one of these departments namely the department of design and development. This department is committed to develop and construct power plants, transmission and super-distribution networks and has eight offices. These offices are: project financial affairs, project provision affairs, contractors and consultants, transmission posts administration, super-distribution posts administration, super-distribution lines administration, transmission lines administration and fiber optic network administration. Three information systems are utilized in these offices: Administrative Automation, Pardaaz and Intranet. The people who utilize these information systems (as end-users) can be classified into two categories: expert end-users and non-expert end-users.

We used doll and Torkzadeh instrument to design a questionnaire. Instead of a Likert-type scale, we considered a ruler-type scale from 0 to 10; in which 0 was the worst score and 10 was the best. Every unit was further divided into five equal units. In this way, the questionnaire would be more accurate and a respondent

could use a number with the maximum accuracy of .2 to express his/her idea about each question.

We took a sample of end-users in the eight offices randomly and after giving a brief description about the study goals, they are asked to answer the questionnaire.

The answers were gathered, and incomplete questionnaires were discarded. Finally 51 remaining questionnaires were utilized to perform validation tests. In this stage, we did convergent validity and reliability tests. As the end-users were classified in two categories, we did discriminant analysis to insure that the satisfaction aspects are not significantly different among these two categories.

After validity confirmation, we analyzed the results using Kruskal-Wallis and two-way ANOVA tests. All tests have been conducted by using SPSS 11.0.

V. VALIDATION TESTS

A. Convergent validity analysis

When within-items correlations in one factor are significantly more than zero and the items are highly correlated with each other, the convergent validity is confirmed. We analyzed correlations within items of each factor using Spearman correlation coefficient.

Established correlation matrix revealed that smallest within-items correlation coefficient for content aspect is .622 and within-items correlations for other factors are: accuracy = .798, format = .747, ease of use = .817 and timeliness = .827. It is obvious that these correlations are significantly more than zero and large enough to encourage further investigation.

B. Reliability analysis

We analyzed the reliability of the instrument by using Cronbach alpha. The amount of Cronbach alpha for 12 items is .9451 and confirms the validity of the instrument. Reliability analysis also revealed that elimination of none of the items will improve the amount of Cronbach alpha.

According to alpha = .9451 we interpret that each respondent has indifferent perceptions of the items of the questionnaire and repeating the sampling process led to the same results. In this way, the reliability of the instrument has been confirmed.

C. Discriminant analysis

Discriminant analysis classifies all members of the population into separate groups in the way that observations of every group are similar to each other. Here, there were two types of end-users: experts and non-experts. Therefore, we should have done discriminate analysis to insure that there is not any significant difference between these two categories.

From all 51 valid questionnaires, 25 questionnaires belonged to expert end-users and other 26 questionnaires belonged to non-expert ones. We tested the following null

hypothesis to find whether these types of end-users are significantly different or not.

H_0: The means of grouping variables (i.e. expert and non-expert) are not significantly different among factors of the questionnaire (i.e. content, accuracy, format, ease of use, timeliness).

The analysis was conducted by using Wilks' Lambda test. By applying F-test we were able to interpret that the amount of Wilk's Lambda is significant or not. As it is shown in table II, there is not significant difference between group means at the level of .05.

TABLE II
TEST OF EQUALITY OF GROUP MEANS

	Wilks' Lambda	F	df_1	df_2	Sig.
Content	.999	.042	1	49	.838
Accuracy	.994	.298	1	49	.587
Format	.992	.399	1	49	.531
Ease of use	.996	.204	1	49	.653
Timeliness	.963	1.889	1	49	.176

VI. ANALYSIS AND RESULTS

After confirmation of the questionnaire validity, we utilized data obtained from the questionnaires to analyze EUISS among the eight offices of the aforementioned department of the company. To do so, Kruskal-Wallis test which is a non-parametric variance analysis tool and two-way ANOVA test were used.

A. Analysis of end-user IS satisfaction levels among offices

First, five satisfaction factors (i.e. content, accuracy, format, ease of use and timeliness) among the eight offices were studied. We defined new variables which were equal to the average scores of items within each factor and called them content, accuracy, format, ease of use and timeliness respectively (in accordance with instrument factors). Using these variables we conducted Kruskal-Wallis test to find whether there was any significant difference in satisfaction level among the eight offices regarding each factor individually. On the other words, this test can reveal significant differences in satisfaction scores given by end-users among the offices with respect to each of the five factors separately. The hypothesis to be tested is stated as following:

H_0: The scores of factor variables are not significantly different between the eight offices.

Descriptive and test statistics are presented in tables III and IV respectively.

TABLE III
KRUSKAL-WALLIS TEST: DESCRIPTIVE STATISTICS

	N	Mean	Std. Deviation	Min.	Max.
Content	51	6.3064	2.14002	1.25	10.00
Accuracy	51	6.8824	1.91444	2.50	10.00
Format	51	6.5716	1.91328	3.00	10.00
Ease of use	51	6.8804	2.03450	1.00	10.00
Timeliness	51	6.8431	2.29811	.50	10.00

Table IV indicates that the scores of content variable are significantly different between the eight offices at the significance level of .05. This statement is also true about the format variable. Therefore, the rankings of the offices in these two factor variables are not random.

TABLE IV
KRUSKAL-WALLIS: TEST STATISTICS

	Content	Accuracy	Format	Ease of use	Timeliness
Chi-Square	14.666	13.430	17.523	9.583	6.471
df	7	7	7	7	7
Asymp. Sig.	.041	.062	.014	.213	.486

B. Analysis of end-user satisfaction levels among information systems

In this stage, the satisfaction factors of three information systems working in the offices are studied. By considering defined variables in previous section, we performed Kruskal-Wallis test to find whether there is any significant difference in satisfaction levels among the three information systems regarding each factor individually or not. We have tested the following hypothesis:

H_0: The scores of factor variable are not significantly different between information systems.

Descriptive statistics are the same as table III and test statistics are presented in table V.

TABLE V
KRUSKAL-WALLIS: TEST STATISTICS

	Content	Accuracy	Format	Ease of use	Timeliness
Chi-Square	.120	3.809	2.685	1.792	4.240
df	2	2	2	2	2
Asymp. Sig.	.942	.149	.261	.408	.120

As shown in the above table, there is not any significant difference in satisfaction levels among the three information systems at the level of .05.

C. Analysis of between-subjects effects

In our study, there were two factors affecting end-users satisfaction with the information systems: the office which an end-user belonged to and the type of information system he/she used to carry out his/her works. Rather than analyzing these factors individually, it is necessary to study their interactive influence on the satisfaction levels. So we conducted two-way ANOVA test.

This test was performed in three steps for each of the five aspects of the IS satisfaction separately. Regarding each aspect, we tried to find whether there is any significant interactive effect between two main factors or

not: office and IS. After being ensured that there was not such an interactive effect, we proceeded to analyze whether the means of satisfaction aspect scores were equal among three information systems. Such an analysis was performed to find whether the means of aspect scores were equal among the eight offices or not. The null hypotheses to be tested are stated in below:

H_0: There is not any significant interactive effect between two main factors namely office and IS.

H_{00}: The means of satisfaction aspect scores are equal among three information systems.

H_{000}: The means of satisfaction aspect scores are equal among the eight offices.

Table VI represents the results.

TABLE VI
TWO-WAY ANOVA TEST: TEST OF BETWEEN-SUBJECTS EFFECTS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Dependent Variable: Content					
Model	2133.772	21	101.608	24.682	.000
Sys.	.830	2	.415	.101	.904
Dep.	56.836	7	8.119	1.972	.093
Sys.*Dep.	39.141	11	3.558	.864	.582
Error	123.499	30	4.117		
Total	2257.271	51			
R Squared = .945 (Adjusted R Squared = .907)					
Dependent Variable: Accuracy					
Model	2515.268	21	119.775	42.934	.000
Sys.	2.415	2	1.207	.433	.653
Dep.	44.224	7	6.318	2.265	.056
Sys.*Dep.	29.316	11	2.665	.955	.505
Error	83.692	30	2.790		
Total	2598.960	51			
R Squared = .968 (Adjusted R Squared = .945)					
Dependent Variable: Format					
Model	2295.518	21	109.310	36.447	.000
Sys.	1.840	2	.920	.307	.738
Dep.	54.525	7	7.789	2.597	.032
Sys.*Dep.	22.401	11	2.036	.679	.747
Error	89.974	30	2.999		
Total	2385.493	51			
R Squared = .962 (Adjusted R Squared = .936)					
Dependent Variable: Ease of use					
Model	2499.261	21	119.012	29.258	.000
Sys.	1.983	2	.992	.244	.785
Dep.	33.765	7	4.824	1.186	.340
Sys.*Dep.	31.794	11	2.890	.711	.719
Error	122.029	30	4.068		
Total	2621.290	51			
R Squared = .953 (Adjusted R Squared = .921)					
Dependent Variable: Timeliness					
Model	2509.604	21	119.505	25.121	.000
Sys.	26.140	2	13.070	2.747	.080
Dep.	30.144	7	4.306	.905	.516
Sys.*Dep.	56.265	11	5.115	1.075	.412
Error	142.716	30	4.757		
Total	2652.320	51			
R Squared = .946 (Adjusted R Squared = .909)					

According to the results shown in the above table, for all five aspects of the IS satisfaction, there was not any

significant interactive effect between two aforementioned factors (i.e. office and IS) at the significance level of .05. Therefore, H_0 hypotheses would all be accepted. This was also true for all H_{00} hypotheses and we could conclude that the level of IS satisfaction in all five aspects did not depend on the IS type.

The mean scores of four satisfaction aspects were also equal among the eight offices. But according to table VI, the means of format scores are not equal at the significance level of .05 (p = .032). In this case, we applied LSD test to reveal that the scores of format factor between which offices are significantly different.

As the minimum R-squared is .945, we infer that offices and IS types explain significant amounts of variations in all five aspects of satisfaction.

VII. SUMMARY

End-user information system satisfaction (EUISS) is a measure which can be utilized to assess the effectiveness or success of information systems. In this paper, we used the broadly accepted 12-items instrument developed by Doll and Torkzadeh to study the end-user IS satisfaction in an Iranian power holding company. A sample of end-users has been taken and asked to answer to a pre-designed questionnaire. Then, validity of the questionnaire was evaluated through convergent validity analysis and reliability tests. For this purpose, we established correlation coefficients and also Cronbach alpha. As the end-users are classified into two categories, we performed discriminant analysis using Wilks' Lambda test to insure that these two categories are not significantly different among satisfaction aspects. In this way, the validity of the questionnaire is confirmed. Kruskal-Wallis and two-way ANOVA tests were used for analyzing EUISS among the eight offices of the aforementioned department of the company. In this stage, end-user satisfaction levels among the offices and the information systems were analyzed individually. As we had two factors affecting end-users satisfaction with information systems, the analysis of between-subjects effects was also done.

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